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AVIATION AND AERONAUTICAL ENGINEERING



British Official

British Bomber About to Start on a Night Raid

Contest Photo Series

VOLUME V
Number 9

Three
Dollars
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SPECIAL FEATURES

- THE HISPANO-SUIZA AIRCRAFT ENGINES
- AN ALL-AMERICAN FIGHTING AIRPLANE
- ORGANIZING FOR AIRCRAFT PRODUCTION
- FUTURE OF THE AIRCRAFT INDUSTRY
- PROPER FUNCTION OF THE ELEVATOR



PUBLISHED SEMI-MONTHLY

BY
THE GARDNER-MOFFAT CO., INC.
120 WEST 32nd ST., NEW YORK

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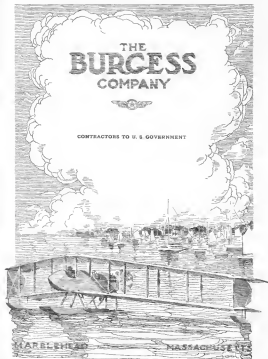
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YOU can't get absolute uniformity in your heat-treated products, nor full capacity from your plant, if your quenching oil is not properly cooled.

S-C-H Oil Cooling Coils are so designed and constructed that quenching oils may be constantly maintained at any desired temperature, insuring constant operation and a uniform product.

The illustration shows one type of cooling and composed of 3 stands of pipe, eight pipes high and twenty feet long. They can be furnished from one stand, four pipes high and ten feet long, or in any capacity.

The S-C-H Cooling Coils consist of 1½" pipe made of 3" pipe. The hot oil flows through the 3" pipe, while the lighter pipe cools the cooling water. The oil radiates its heat not only to the water, but also to the air, giving double cooling power to the coils. The flow of oil and water is so arranged that the hot-

test oil comes in contact with the hottest water, thus obtaining the full cooling power of the water.

The coil shows complete round face space—3" wide by 2' long. By its use 1200 pounds of steel at 1000° F. may be quenched in an hour. To do this it requires 20 gallons of water and 40 gallons of oil per minute. Temperature of inlet water 60° F. Temperature of inlet oil 130° F. Temperature of hot oil and water at outlet 90° F.

Write for full specifications and prices of S-C-H Cooling Coils. Same capacity wanted.

THE STRONG, CARLISLE & HAMMOND CO.

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THE GARDNER-MOFFAT COMPANY, 129 WEST 32D STREET, NEW YORK

DECEMBER 1, 1918

AVIATION AND AERONAUTICAL ENGINEERING

VOL. V, NO. 9

Member of the Audit Bureau of Circulations

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WYMAN-GORDON

Airplane Crankshafts



THE STANDARD OF THE WORLD

Wyman-Gordon Company

Worcester, Mass., U. S. A.

Hispano-Suiza engine, known as model H, was put under test

used by *l'Armée de l'Air*. Although the exploits of the leading French men are familiar to every one, comparatively few people are aware that most of these drive planes equipped with Hispano-Suiza engines.

A good illustration of the success of French designers, Hispano-Suiza, Lorraine, and others, are worthy of mention. Many British and American men are their lives and their nations and models to the dependable performance of their Hispano-Suiza power plants.

Holds a world's altitude record.

Hispano-Suiza engine have held the world's record for altitude for some time, the most recent one having been established at Dayton, Ohio, Sept. 18, 1928.

This flight was made by a captain in the Air Service of the United States Army, who attained a height of 35,000 ft. in a Bristol biplane driven by a 300 hp Hispano-Suiza engine.

That is not all. This upward was not due to limitations in engine performance, but because of the extremely low temperatures which tend to the power of the engine of the altitude.

At 35,000 ft. the temperature was about 70 deg. Fahr below zero. On altitude, 300 miles from his starting point, the aviator found that he had frozen his lips and four fingers.

Design is Perfect

The Durkig patents cover the manufacture of all Hispano-Suiza engines. These patents are owned by the designer of the engine, Marc Durkig, and the parent company, Automobile Hispano-Suiza, which has a factory at Barcelona, Spain.

Advantages in Construction

Great lightness and flexibility, high-power development, simplicity of design and ease of manufacture are characteristics of Hispano-Suiza construction. Low in base and low engine are required for manufacturing the Hispano-Suiza than for any other power plant of similar capacity which is being built at the present time.

A comparison with the German Mercedes aircraft engine factory, striking contrast of Hispano-Suiza simplicity, the Mercedes having about 900 parts to 490 in the make-up of the

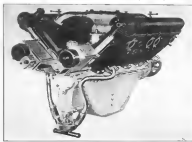


FIG. 2. ANTI-PROPELLER END VIEW

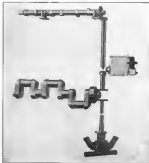


FIG. 3. CRANKSHAFT, MAIN DRIVE AND PUMP DRIVE

Hispano-Suiza. It is stated that the amount of material needed for a Hispano-Suiza engine weighs something less than that required for a Mercedes engine of the same power development.

100 a Day in Europe

Approximately 150 Hispano-Suiza engines a day are produced in European factories, 150 being the average daily output of the seven main French factories engaged in this work. The parent company at Suresnes, France, is producing rapidly, and one of its subsidiaries in England building the Hispano-Suiza, a turning out about ten a day. A company has been formed in Italy and another in Japan to produce Hispano-Suiza engines, as neither has started production.

Big Factor in U. S. Program

Hispano-Suiza could not meet the demand for Hispano-Suiza engines in 1918, so manufacturing rights were given to the Wright-Martin Aircraft Corporation, New

Haven, N. Y. This corporation has been producing these engines ever since, constantly increasing quantities. On the side of the United States, in the war, which were used by the American Government for thousands of Hispano-Suiza engines to meet the requirements of all branches of the armed forces.

As these orders were placed, the Wright-Martin Corporation made an agreement with other plants to take on such an order.

Four Types Made Here

Four models of Hispano-Suiza engine have been produced in the United States. These are designated Models A, E, H and R.

Model A has a bore of 100 mm. (4.72 in.) and a stroke of 125 mm. (5.12 in.), and develops 300 hp. at 1400 rpm. at sea level. Although formerly used for pusher and puller work, this engine has now been redesigned to use it in tractor planes.

Model E, also of 100 hp. at the same as Model A, except that it has the same stroke as Model A, but the crank type of connecting rod, the magneto drive and the timing are different, and there are some slight modifications.

While Model E has the same bore and stroke as Model A

and E, it develops 180 hp. the compression ratio having been raised from 8.75 to 1 in the Model E to 9.5 to 1 by decreasing the distance from the center of the piston pin to the top of the piston. A larger blending carburetor with 2 in. diameter is used instead of the smaller one fitted to the Model A. This is necessary to take care of the increased volume of air.

outlast there. It is a three-cylinder, semi-cooled engine, with eight cylinders arranged in two blocks of four, which are set at an angle of 60 deg. The aluminum crank case is divided in the center line of the crank shaft, the faces of the two halves being ground to a perfect fit, no gasket is used between them. They are fastened together by bolts. The lower half

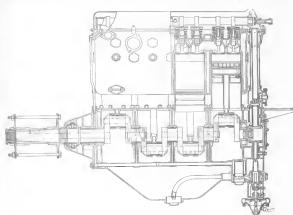


FIG. 4. CRANK SHAFT AND CRANK, SIDE VIEW

was required by the higher engine speed of the Model R, the 1800 rpm. greater than in the Model E. The Model R has been widely employed fitted to French S.E. 5 planes, which are designed for combat and general purpose work.

The four models mentioned above resemble the original French design very closely in their essential features, although incorporating a number of variations in dimensions and details of design.

The 300 hp. type, Model R, may be characterized as entirely American except for its basic principle. The Wright-Martin experimental department at New Haven has completed about twenty of these engines, and they are stated to have proved unusually powerful and speedy. The bore of the Model R is 100 mm. (4.72 in.) and the stroke is 150 mm. (5.90 in.). Two other important features which are different in the Model R are equipped with the other three engines are the magneto and oiling system. Like the others, however, this model is designed for lighting, pursuit and similar activities.

Mechanical Details

The Model I Hispano-Suiza may be described as typical of the entire series, with the exception of the points of difference

of the crank case is unusually deep, forming a large oil reservoir and also oiling the engine. The upper half carries the two-cylinder blocks, flanges at the base of the cylinders being flanged by means of bolts.

Four Thrust Crank Shaft

A four-three crank shaft is used, 180 deg. between throws. It is made of chrome nickel steel, machined all over and is hollow for lightness. Four plain main bearings, linearly located and lined with babbitt, and one central ball main bearing at the rear (magneto end) of the engine carry the shaft, which is supported between the crank case halves. A double-row, ball-bearing bearing located in the front of the crank case takes the thrust of either a tractor or pusher propeller. The crank shaft is provided with a taper at the front end, having a key for the propeller hub.

Aluminum Cylinder Blocks

The cylinder blocks are of cast aluminum and incorporate water-pockets surrounding the heads of the forged steel pistons, which are made in the form of sleeves, tapered at the outside to screw into corresponding threads, which are quickly

The L-W-F Model G-2 Fighting Airplane

By Glenn D. Mitchell
Chief Engineer, L-W-F Engineering Co.

From the entry of the United States into the World War, an all-American designed fighting airplane has been used at the front. In the great rush and bustle to get American-made fighting machines in the hands of the front, no time was given American engineers and designers to perfect any particular construction or designed machine of the type required. Constructors were placed immediately for the more successful designs



FIG. 1. Side View of the Model G-2

of the Allies and all that was left for American engineers to do was to use their closed capacity to adapt American production methods to these foreign types. This they did with such success that the airplane production has been more than sufficient. But, true to American tenacity these engineers did not give up hope and very quickly covered the types worked upon with designs of fighting machines, a conventional model of which have more demonstrated their ability to compete successfully with, if not exceed, the performance of the foreign designs for the same purposes.

Among the most successful of the all-American designs is the L-W-F machine, the first experimental model of which was in the air early in January, 1918. This first machine, known as Model G, which is shown in Fig. 2, was powered with a Liberty 12 motor and was taken off with the wood, balsa and balsa the first time it was in the air.

Model G-1, an improvement over Model G, was built and flown successfully during the summer of 1918, demonstrating before various government officials its speed, climb and carrying capacity. This machine, loaded as a fighter with full tanks, seven machine guns, ammunition, pilot and ground crew, made 120 m.p.h. and climbed 10,000 ft. in ten minutes.

Later in the summer, Model G-2 was introduced, carrying more power, doubling the number of wing ribs and later installing a wing spar in the tail. The following description refers to the latter machine, Model G-2, which, as before stated, is a modification of Models G and G-1.

General Description.—Model G-2 is a general service, 420-450 hp., two-man biplane of the latest design, military type, armed, and carries an armament of seven machine guns. As addition it can also be equipped with four large bombs. As will be noted, a wing root radiator was used in the time the plane for the accompanying burner was used. All parts of the machine seen from above are finished in earth brown while from below it is sky blue. The general specifications follow:

DESCRIPTION

General weight on the ground, 2,500 lb. (including pilot, fuel, oil, and armament). Empty weight, 1,500 lb. (including pilot, fuel, oil, and armament). Empty weight, 1,500 lb. (including pilot, fuel, oil, and armament).

Power: Liberty 12, 120 hp., 1,200 ft. (including pilot, fuel, oil, and armament). Empty weight, 1,500 lb. (including pilot, fuel, oil, and armament).

Wing: 120 ft. (including pilot, fuel, oil, and armament). Empty weight, 1,500 lb. (including pilot, fuel, oil, and armament).

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The fuselage is connected closely together at the center of the machine by external struts, while the wings are hinged to a tubular framework suspended below the body and hinged to



FIG. 3. COCKPIT OF THE L-W-F Model G-2, with Two Machine Guns. It is at the front of the fuselage. The space between the panels, which is a little wider than the body, is left open. The illustrations show the machine before this change was made. The rear view of both upper and lower wings are cut away at the body to give a better view and angle of line. (Fig. 5, plan view). The wing structure is of the standard Pratt truss type with



FIG. 2. Model G-1 in Flight

Continued Design.—In the design of this machine the reduction of load resistance has been consistently kept in mind. All possible parts being well streamlined. The engine is almost enclosed. (Fig. 3, side view) only the cylinder heads being exposed, thus adding to the efficiency of the cooling system. The double wing is strengthened with a grooved spar and stays lagged between the two wings. The landing gear, which is a standard Pratt truss type with

Body.—The body is of the monocoque type of construction, being built over a streamline shaped mold, of three layers of 1/4 in. spruce, with four top wings spruce from tail to nose between the middle and rear and outer layers. The two outer laminations are sprayed in opposite directions while the inner laminations are straightened and left. All three laminations and the two layers of top are laid in but plan. The outside is covered with heavy paper or oil cloth, making the complete shell approximately 1/4 in. thick. The type of body covering is spraying except at the engine and where the wings and tail skin are attached. The frame at these points consists of my cold rolled steel plate formed of bent up angles and inserted in the inside of the body with bolts and nuts made alternately. Faint one, two and three carry the engine block, engine three and four carry the wing structure, while five and six support the tail skin. The frame is a sturdy, resilient body and one which is easily repaired. The approximate weight of the finished body, including all brackets, plates, engine block, engine three and four, standard inner and, and tail skin complete is 300 lb. A slender type of body is then covered, fitted under an oil cloth and painted with a load of over 5,000 lb. in the engine section and an equivalent load of 35 lb. per sq. ft. on the tail surfaces.

Wings.—There are two upper and two lower wing panels



FIG. 4. REAR COCKPIT OF THE L-W-F Model G-2, with Three Glass Porting Down. Two sets of struts on each side of the body and an exhaust at the center over the engine's exhaust. This exhaust is composed of one steel tube open at the front, with a combination of two spruce ones "V" shaped and two diagonal strengthened steel tubes forming an oblique pattern whose apex is at the rear under wing structure. This arrangement (shown in Figs. 5 and 6) gives better vision, more space and streamlines the fuselage than making the pilot's cockpit open to the rear. The main wing struts are of solid spruce with steel sections in the center composed of a sheet steel plate welded to a drag braced steel base. A tongue on the base is ground between two legs on the wing fitting. Each lower panel is fitted with a steel tube wing up and down in Fig. 4.

The wings are built up in the most familiar way, using front and rear spars, 4 beams riveted out for lightness, the corners of the wing webs being into the running. The ribs are spaced approximately 11 in. an engine being mounted together at the body end of the panel. The webs are of lightened bass wood and the spars are spruce. A strip of two-

The tail stick or shank, like there are two, are made of oak or hickory. The main tail stick (Fig. 3, side elevation) is provided with a universal joint where it passes into the body. The upper end of this stick is secured by rubber strapping made to body plate washer 2. The other stick is a fixed emergency member to hold the tail high enough from the ground



FIG. 2. THREE-QUARTER FRONT VIEW OF LIBERTY ENGINE AND FIXED MAINLINE GEAR

ply sheave covers the upper surface of the nose to the center of the front beam. Lateral wing bracing is of the usual type.

Tail—The horizontal stabilizer is in two halves bolted to each side of the body. The front stabilizer beam projects at the inner and outer ends with the opposite beam in a rectangular steel box riveted inside the body. The stabilizer rear beam is also of spruce with the leading edge in a bent steel tube. To remove the complete stabilizer it is only necessary to take off the beams and take out four bolts.

The elevators are built up of spruce front and rear beams with wooden ribs and a dished steel tube edge and are braced to the stabilizer with male and female eyebolt lugs. The elevator construction is similar to that of the stabilizer. The rubber and vertical bar have steel tube frames filled in with wooden ribs.

Landing Gear—This is of the "V" type. Two 1 1/2 in. 10 gauge steel tubes are bent to form the beams with hinges on sections welded up each end. In the bottom of the "V" a 2 1/2 in. steel guide plate is welded. A bronze bush, carrying the 1 in. diameter by 1/4 in. ball roller-rail steel axle, slides in the guide. Steel axles are slipped on the axle at either side of the bronze guide block and over these and the bottom of the "V" the shock absorber of 1/2 Goodyear standard coil is sprung. A ballast strap holds it in place. The "V" limbs are braced by two 1/2 in. steel cables running respectively to opposite sides of the body and by two 3/8 in. steel cross tubes, enclosed in a brass wood strapping secured to maintain the axle. Standard wire wheels are used, covered with deerskin hooves.

to protect the elevator since should the main stick be broken.

Controls—A fixed stick control is provided, with the stick in the gasoline's cockpit removable. The rubber is supported in the emergency way, while the elevator wires run to arms on the outside of the body. The elevator wires are enclosed in the wings and run directly into the body to a quadrant on the control stick.

Exhaust—The engine is equipped with exhaust pipes terminating in a fixed type of muffler (Fig. 4).

Fuel System—There are two main fuel tanks, one between pilot and engine, and one bulk under and around the pilot's seat. A smaller auxiliary tank is used, there being an auxiliary fuel pump in each cockpit, so that in case of emergency the engine can help the pilot keep up the pressure. Shut-off valves in the main line are operated from the pilot's seat.

An auxiliary oil tank is placed beneath the engine feeding direct into the oil pump.

Engine Controls—The spark and throttle levers are at one side of the pilot, on the same surface of the body, and operate the engine through rods and bell cranks.

Armure—The over-releasing hand mechanism by performing the armature the armature link is secured with a span wire, main rear, or none. This part is cut to fit the blades of the armature and held in a shaped up spider caught under the blades of the armature links.

Cooling System—As shown in Fig. 5, the upper water pumpers of the radiator are in the wing center. The radiator proved very satisfactory and was only replaced once

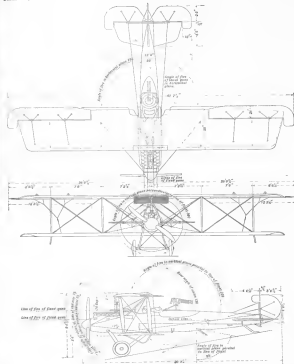


FIG. 3. OUTLINE DRAWINGS OF MODEL G-2

Future of the Aircraft Industry

By Harry Bowers Mingle
President, Standard Aircraft Corporation

In growing consideration to the status of the aircraft industry, reasonable thought must be expended in order to obtain the picture within its proper limits at present time, for while it is assumed that the progress of the aircraft industry will be very rapid and will result into fields hitherto unknown or unimagined, it is reasonable to state that these developments will be about sensible limits.

The possibilities of airplanes of large size and maximum horsepower are certain, but to be immediately realized they depend largely upon the ability of the district in which they are to be used, in properly provide for their housing and landing.



THE FIRST MACHINE BARRY HANCOCK FLEW OF THE STANDARD AIRCRAFT CO.

Further to realize that airplanes must immediately have their places in land, it would seem that now is the time for all of the states and civic subdivisions of states to turn their attention to the possibility of establishing landing fields within the districts of proper size and convenience to permit along the direct routes which are to be established between the principal cities.

As these landing fields and routes are established and developed, the types of airplane which will be used to maintain connections between them will be correspondingly advanced. The standard service of the airplane will be accompanied by an increased demand for types of planes of a really commercial design and the manufacturers will be able to keep pace with this demand.

One point at a long time in which to make the prediction of the development of the aircraft industry and in order to hold the correct attitude of our nation, it would be somewhat unwise to discount the years to come that lay before us. It would be more consistent with our present progress to limit our prediction to the next twelve months during which time the industry will have readjusted itself to the present time conditions and will be, at that time, in a position to take up the commercial requirements as the urgent needs indicate as being desirable and essential.

With the completion of wartime, aircraft manufacturers who have established their enterprises solely for the purpose of making the military requirements during the war period are coming with grave consideration their future prospects. Their experience as manufacturers of aircraft on a wartime program will not be of much use to them in the manufacture and sale of commercial airplanes and when entering the open market on a competitive basis.

They are handicapped by the fact that their designs are of a purely military type, that the process of manufacturing is on a made fast to almost the limits of the commercial types of machines for sometime to come, that the experience they have acquired in the development of the military types

cannot be used to the same advantage in the commercial field. The staff and personnel will not be able to meet the new conditions with the same facility as when they entered the field during the war. The experience they have acquired is entirely different from aircraft experience which goes with a peace time program and to readjust their minds to this new condition will not take back just so long as the period of business time requires.

As a consequence of these limitations, the development of the commercial airplane and the manufacture of aircraft for nearly seven years time will be undisturbed only by the output of the airplane manufacturers. Among the few who

will survive the period of readjustment will be those who have acquired a pre-war experience and who are now more than ever fully capable of meeting the new demands of the future.

The Standard Aircraft Corporation with its plant at Elizabeth, New Jersey, will be one of the plants to maintain its activities after the war. This company will remain to its original pre-war plans, those having been laid aside temporarily to make the company to participate in the military and naval requirements. The "Standard" will continue in the manufacture of aircraft of all types and will create special designs to meet the new requirements. They will keep out in advance of the trend of progress which has characterized its efforts throughout its history. This company has made rapid strides during the war and thus, coupled with its pre-war experience, will enable it to move and maintain a position in the newest industry well up in the front ranks. Their efforts will help to directly establish the airplane as a means of transportation and an important element of public safety.

Possible Use of the Airplane

In contemplating the use to which airplanes may be utilized in an advance of the possibilities are:

(1) *Police the Air.* Airplane of a special design making the demands of speed, mobility, sturdiness of construction, high ceiling, and low landing speed. This type must be absolutely dependable for the special use to which it will be placed, that is, to maintain a proper regulation of the traffic of the air highways.

(2) *Coast Patrol and Navy Service.* In order to maintain contact between the authorities who have jurisdiction over the aerial highways over land, the naval authorities will extend their service to a system of patrolling the sea coast and will extend the service to cover the inland waterways, the Great Lakes and the Pacific Coast. For this service a type of machine which will be useful to the greatest requirements. This will be a modification of the type which is now in use so that the aircraft will have adequate protection against exposure to the weather. With this will also be developed a

type of airplane that will be used by the Internal Revenue service to properly maintain the regulation of that department as rivers and harbors.

(3) *Military Purpose.* The activities of the Army in the maintenance of the military establishment during peace time will require the use of airplanes as a means of maintaining contact between the various military districts and administrative centers. With this will also be given consideration to the transportation of personnel for emergency service, also to participate in the regulation of the air traffic and to apply the



THE HU-1L NAVAL FLIGHT BOAT BUILT BY THE STANDARD AIRCRAFT CO.

rules for landing on fields and water to that landings, forest or otherwise, may be properly provided for and regulated.

(4) *Express Service.* In this service, a type of aircraft will be developed that will carry two thousand pounds, or more, of valuable lighted express packages. These express planes will operate between large cities and will ultimately reach a medium service between the extreme east and west coasts.

(5) *Naval and Coast Patrol.* There will be established a line of communication between the north and south in more direct routes than are now in operation, which will do much to carry in the track line of valuable sea commerce for further development of branch lines.

(6) *Post Office and Mail Service.* The greater work of the Post Office Department in establishing aerial mail service will be of considerable benefit to the commercial development of the country in the further expansion of the service. It is reasonable to predict that every city of importance will have a well service that will be frequent and dependable by means of the Post Office planes.

Outlying towns and districts which are not now frequented aerial will have the advantage of contact with the largest commercial centers.

In order to meet the needs and varied requirements of the Post Office Department, the activities of the manufacturers will undoubtedly be directed to the development of three different types of airplanes, each one fulfilling a definite requirement of the service.

(7) *Fast Passenger Service.* At first a small number of people will take themselves of the opportunity to make long distances in a short length of time and as the necessity of the service becomes apparent, and where the time is desired and the business aspect, business men will be glad to avail themselves of the opportunity of the aerial passenger routes. A type of plane which is now in operation was developed to meet the requirements of this particular service.

(8) *Trans-Atlantic Flight.* Airplane development will take place in the maintenance of trans-Atlantic airplane service in its extent this will make a use of the most important advance in the commercial development of the world. The types of machine which will be used in this service will be a further development of the type which is now in use and the business and will be probably a combination of two two. It is certain, however, for the more widely experienced manufacturers and

designers to carefully go into the development of this particular type of plane, as it involves many considerations which need to be refined to a degree that will make trans-Atlantic flying a commercial proposition. But the time for the class of aircraft is also at hand.

(9) *Trans-American.* The attainment of the possibility of the development of both civil and military air service in North America will mean many airplanes to speed considerable time, money and effort to make a big profit. In looking at this dream of trans-Atlantic service, there must be considerable

thought given to the limitations of the countries in which the airplane is to be used.

While the opportunity is undoubtedly present for a development that will be completely profitable, we believe that the markets at home should be more fully developed before making the attempt to enter into foreign fields.

(10) *Alaska.* The great route to the Alaskan district have been fully laid out to light by reason of the fact that this route cannot be built except in the cost of isolated efforts and extending over a long period of time. The possibilities of establishing and maintaining a system of airplane routes through the Alaskan district is undoubtedly before us. Without being required to make any unreasonable changes in the present types of planes, it is reasonable to think that we should be in a position to maintain a system of service that will provide a prompt return in a relatively small investment. This perhaps one of the most extraordinary opportunities for commercial development that this country can offer.

(11) *Mapping.* The United States Geologic Survey and similar departments will be able to utilize the services of the experienced aviators and the military types of photographic cameras without change for the purpose of making a topographic photographic record of the topography of the United States and its surrounding coast lines. This is a service that can be started at once and be continued as a part of the military program.

(12) *Agroaerial Department.* The Department of Agriculture will have the advantage of the use of airplanes in the investigation of the possibility of developing certain parts of the country by aerial means, securing much of the work of such because of the great risk and difficulty in gaining access to them. This will open in their estimate to become known a new industry of great promise.

(13) *Fire-fighting.* The Department of Forestry will be placed in a position to give a more efficient service by reason of maintaining an airplane patrol service over the forested areas; it will also be able to make accurate maps of the forested areas which have not been previously, releasing in the commercial markets a class of timber which contains the finest of materials.

(14) *Fire-fighting.* The value of airplanes in fire-fighting is a service that the companies of this country and other countries which have hitherto not been fully explored is apparent. The educational value of the information obtained through

this machine will be of a high order and the tendency of opinion here will emphasize the true aspect of the demand in all its phases. It will be sufficiently large to present a complete picture of territory hitherto unknown.

(15) *Spotting Types of Airplane*. Spottermen will interest



SPOTTERMEN WILL BE INTERESTED IN THE 150 HP HISPANO-SUIZA ENGINE TAXIING OUT

themselves keenly in the use of airplanes for covering those to the various points throughout the country which they will have the opportunity to display their skill and exercise their desire for adventure. Aerialists will be used in every conceivable form for the satisfaction of the spotterman's interest, in all its phases. Airplanes of various types will be designed and constructed to meet their requirements. Many of these will be of a standardized type, others will be made to suit the individual taste of the aviator.

Altogether, whatever should be taken of the opportunity offered to satisfy the spotterman's demands, there should be included in a well balanced organization a number of spotting types of aircraft and these should be designed especially for that purpose.

Thus briefly outline the use to which an airplane may be put. But there is something more, and that is the opportunity of aviators to place itself in a position of absolute supremacy through the development of the air service, the value of which will become more apparent as time goes on.

To establish the proper emphasis in the different classes of service which are under discussion, in the work which must be done at this time. It is reasonable that the initial efforts of the aircraft manufacturers should not be allowed to revolve themselves into confusion and that aircraft in aircraft will be continued under a strong demand.

That the government is to see their encouragement to the commercial development of airplanes to the same extent as it has the military and naval needs during the war is a reasonable assumption of primary importance.

The operation of civil aerial transportation services are actively different from that of a railroad, motor truck or steamship service and an amount of the greater confidence of operation of the service enterprises, governmental support is both essential and desirable.

We all look forward to the time when the demand for commercial aircraft will be great enough to maintain a thriving industry, and it is recognized that before that is accomplished their entry market will have passed, such little new experiments and hopes.



The pioneer manufacturers during this period will have the advantage of their early experience, but they must have substantial demand in their efforts. Thus the Government could supply through the military, naval and civil branches.

It is not contemplated that vast appropriations of money will be placed at the manufacturers' disposal as during war, but it is reasonable to assume that each of the three branches of the Government will find that certain types of aircraft are needed to meet their particular requirements and these types must be especially designed, constructed and put into service with that object in view.

In stating this objection, it is of importance that the Government should be as generous as it is consistent with economic wisdom. Out of the general confidence in its many of our industries in other forms has been the possibility of effect due to a lack of substantial support or a limited market. In the aircraft industry, until such day when the limited market will have become expanded to a more universal scope, the Government should find it support in every possible direction.

Among the many new things which will be needed to replace the development of the commercial airplane is the question of federal legislation to provide for the proper licensing of pilots and aircraft.

It will also be necessary to provide for the establishment and maintenance of service areas and roads of travel in order to facilitate the use of the aircraft in the future which will regulate the traffic should be made with a view of giving the fullest assistance in the commercial development and growth. Because of the increasing involvement of the State in the air and the air-subdivisions within the State, it is reasonable that these laws should be administered by the military and naval authorities rather than by the civil authorities, it being inadvisable to place the burden of control on the shoulders with highway, railroad and similar public utilities.

Book Reviews

ANATOMY AND PHYSIOLOGY OF THE HUMAN BODY. By J. B. HARRIS. Philadelphia: W. B. Saunders Co., Philadelphia. Price, \$1.00. 356 pp. Illustrated. This short handbook has been written in simple, non-technical language in a systematic classification in the fields of anatomy and physiology. The book is written in a simple, non-technical language. Though its language is as simple as possible, and the various aspects of things are treated in what may seem to be a somewhat superficial manner, it is a book which will easily furnish most necessary information for the purpose of conveying to the totally uninitiated a working knowledge of anatomy. That the interest of the public whose interest began to be aroused by the progress of air transport, and to speed of aerometer reporters on the staff of daily papers, will find it worth their while to read this little book.

REMARKS MADE ON THE SHIP AND AIRCRAFT. By CHAS. L. LEE. New York: The Century Co., New York. Price, \$1.00. 128 pp. Illustrated. Written in a simple, readable manner, this book of handy pocket size explains the modern method of engineering and aircraft, which is known by the name of its designer, Adam Smith. It is a book which is written in a simple, readable manner, this book of handy pocket size explains the modern method of engineering and aircraft, which is known by the name of its designer, Adam Smith. It is a book which is written in a simple, readable manner, this book of handy pocket size explains the modern method of engineering and aircraft, which is known by the name of its designer, Adam Smith.

The value of the book is really derived to the use of the book to find the position of the air and the air, and also in a comparatively simple manner of the present navigation and aircraft, whose use is as of course, to find the position in the shortest time and with the least amount of fatigue. The necessary charts, diagrams and tables are included in the text.

Performance and Cost of the Air Mail Service

Second Assistant Postmaster Otto Franzer has issued reports on the performance of the Air Mail Service during the month of October and an analysis of operating expenses during September. These reports are printed herewith.

It should be noted that in the tables of operation and construction the airplanes mentioned 1.6 new standard Hispano engines, while the same 30 and 20 are Curtiss airplanes, and Curtiss-Liberty airplanes, respectively.

A comparison of the corresponding report of operation and maintenance with that issued for the month of January, which was published on the Nov. 1, 1918, issue of *AVIATION AND AERIAL ENGINEERING*, shows that the Post Office Department continues to better its record of efficiency in operating the Air Mail Service. While the total cost of the service shows a slight increase, \$6,000.74 as against \$5,000.67 for August, this is obviously due to initial expenditures incurred in acquiring a new air mail route from New York to Chicago, an item also included in the cost per hour of operation, which was \$47.90 in September, as against \$47.60 in August.

Considering the above items as well as the economies which have resulted from the advance of autumn, the showing made in September appears particularly good. Cost of repairs and maintenance has dropped from \$1,129.66 in August, to \$699.02, and the total of profits of goods consumed shows a reduction from \$3,334.10 in August, to \$2,442, and the total flight mileage has increased from 15,130 to 18,765, and the cost per hour of operation has been reduced from \$47.60 in August, to \$46.15. On the other hand a better showing has been made in maintenance, the average for September having been 4.42 as against 4.80 for August.

The postal list has been further increased by the addition of a new airplane, a number of postal airplanes destined for the New York Chicago route is now building and nearing completion. The Post Office Department proposes to inaugurate this route during the first fortnight of December.

OPERATING COSTS OF THE AIR MAIL SERVICE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

OPERATING COSTS OF THE AIR MAIL SERVICE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

OPERATING COSTS OF THE AIR MAIL SERVICE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
Maintenance	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66	\$1,129.66
Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

AIR MAIL PERFORMANCE, OCTOBER, 1919.

Category	Actuals	Estimated	Actuals	Estimated	Actuals	Estimated
Operating Costs	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67	\$5,000.67
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Construction	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00	\$2,442.00
Profit	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10	\$3,334.10
Total	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43	\$11,906.43

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Digest of the Foreign Aeronautical Press

Aeronautics, Oct. 2, 1912

Aluminum and Its Alloy—Their Future After the War. Paper read by Dr. Houshian, F.R.S., at the British Scientific Feasibility Conference, Sept. 4, 1912.—Since 1914 very great and vital importance studies have been made in the development of aluminum alloys for many purposes on the largest scale. Most of these refer to the improvement of aircraft and, consequently, it is not possible to deal with them in the general discussion.



GERMAN COMBAT AIRCRAFT FROM THE BALLOON, AFTER IT HAS BEEN FIRED BY ANTI-AIRCRAFT GUNS.

The use and possibilities of aluminum alloys in aircraft are, however, at this time, advance chemistry, and the field are there further extended in future commercial aeronautics are being used and understood.

The valuable properties of aluminum and its alloys depend upon the grain structure of the metal. The grain structure is a specific grain of about 100 microns compared with 70 in the case of steel, or putting it in another way, while a cube of steel of about 100 microns is a cube of aluminum will weigh about 100 lb. But before we start in at this volume, for the most part, aluminum, with a tensile strength of from 2 to 3 tons per square inch, still falls far below for engineering purposes. What is required is a combination of great strength with lightness. This has been attained to an astonishing degree in the modern aluminum alloys. As an example (the material used in the construction of a French biplane) springs from which can be used. This has a density of about 2.6 and a tensile strength of about 35 tons per square inch. This example has been chosen because the same can be given without making unnecessary information, and also because it is well within the limit to state that alloys considerably better than this have been developed by us. But even this example is sufficiently striking.

The effect of this combination of strength and lightness may be illustrated by imagining a very long vertical bar of metal to be hung up by an upper end. The longer such a bar is made, the greater the pull or tensile stress on the upper end, and, of course, until ultimately a length of a bar is reached which can only just support its own weight. The length of such an

imaginary bar—which can be easily calculated if the density and strength of the metal are known—gives a very good measure of the value or "figure of merit" of the material in question, it depends upon the ratio of the density or weight of the metal to the tensile strength. Now in the case of good alloys of structural steel, such as is used for rails and bridges, the tensile length of bar which could just bear its own weight effect suspended vertically would be about 30,000 feet—rather less than four miles. For the alloy described above, on the other hand, the tensile weight would be about 30,000 ft., or between one and two miles. And for the still better alloys which are now available, the length would be considerably greater still.

The aeroplane, Oct. 2, 1912

An Transport Companies Formed—The Anglo-American Aerial Services, Limited, have been formed to establish, maintain, and operate lines of aerial communication between the United Kingdom and the United States, Canada, and Central and



PERMITS HISTORY FROM A BETTER OBSERVATION BALLOON.

South America, and between the continents of North and South America, and to carry on the business of manufacture of and delivery in aircraft, engines and aerodrome propellers, tourist agencies, excursions, etc.

The London and Provincial Aerial Services, Limited, has been formed with the object of dealing with the same.

According to advices from Birmingham, an air traffic company has been formed there with a share capital of two million French francs (French).

Cable messages from Sydney state that a local company has been formed with the object of arranging the performance of an aerial mail service between Australia and England. At a meeting in Sydney, on October 2, of representatives business men, it was stated that the share capital of the company, and sufficient capital was guaranteed for the purpose, provided that permission was obtainable.

New Type of Rotary Engine

It does not require demonstration to state that no other single factor has had such far-reaching influence on the present development of the airplane as the rotary engine, and particularly its first successful representative, the Daimler. At the time of its appearance, the rotary engine was considered, at least so much as that the stationary type, derived from automobile gasoline, had little chance to make the preponderance of the rotary.

The striking success of the rotary engine was almost entirely due to its low specific weight. But its weight per horsepower, which was nearly obtained, as it was known by the absence of a crankshaft and a crank pin. This feature of light weight was an important factor in the design of the engine in the form of the engine in the construction of light rubber and wooden structures, airplanes represented considerable dead weight, and accordingly carried very small useful loads, that the advantages of the rotary decidedly outweighed its drawbacks, most of which were quite of a serious nature. Principal among these drawbacks was high fuel and oil consumption, lack of flexibility, owing to extensive valve gear, and a certain structural weakness in bearing in unobtainable, which was due to the fixed rod and crank mechanism, afforded the valve mechanism.

While some of these drawbacks were eventually overcome, greater reliability and durability, and lower oil consumption, were obtained by the adoption of numerous intake valves (Le Rhône), and the single valve mechanism (Climax monopropeller), other problems arose as the rotary developed in power. During the development of the rotary engine, the number of cylinders has varied from 2 to 12, and not only by the diameter of the cylinders, but also by the number of connecting rods that could be fitted, without initial interference, in the crankshaft. As a consequence, there was a limit to the increase in power by means of increasing the number of cylinders—the number having never exceeded more than eight, though there have been reports with 16 cylinders, disposed in two rows—and beyond that limit the power could be increased only by increasing the volume of the cylinders. This would obviously demand a larger crankshaft, the result that—beyond a certain power—greater number of the rotary would increase in proportion to the power developed.

One increase in the dimensions of rotary engine pistons, however, a terrible drawback, first, it increases the resistance to air resistance, thus requiring a larger airplane body and increasing parasite resistance; and second, it increases in air resistance due to an increase in weight, the aerodynamic loss generated by such a mass, riding at a high rate of speed, has a distinctly unfavorable influence on a highly sensitive airplane, such as present machines, while type particularly requires to engine of low specific weight.

The above considerations explain why the power of rotary engines is virtually limited to about 150 hp, and why, the engines of higher power, the stationary type has now come to be regarded almost as a dogma.

Nevertheless, it might be worth while examining whether the possibility of rotary engine could not advantageously be retained for air-engines, were it possible to do away with the above-mentioned drawbacks, that is, reduce wastage of fuel and oil, and increase resistance, with its subsidiary effects.

An engine in which an attempt is made to coordinate these somewhat conflicting principles, and which has actually been

built and tested, is described by Vincent Clarke in *Flying* (London). This engine, called the Stirling, is at what may be called the parallel-rotary type, and includes some very interesting features, not the least of which is the apparent simplicity of its general arrangement and the lack of complicated parts.

A three-cylinder engine was first constructed, having a cylinder 30 mm diameter by 30 mm stroke and it developed 10 hp when running at a speed of 1,000 r.p.m. This was increased and gave good results in test, but ultimately it was found to be of much interest from an engine point of view. A larger Stirling engine was constructed with five cylinders, 100 mm bore by 100 mm stroke, and when running at 1,000 r.p.m. its output of 44 hp was obtained.

From the aerodynamic results of these engines a 100 hp one was developed, having six cylinders, 30 mm diameter and 100 mm stroke. One of the chief advantages of this parallel-rotary type of engine is that owing to the disposition of the cylinders, the engine is of very small diameter as compared with any other air engine, which permits parasite resistance to be reduced, and allows the airframe to be considerably more efficient. Referring to the diagram above, if we see that the cylinders are arranged parallel to a fixed shaft, around which they rotate. Nickel steel cylinders are used, they being machined out of the solid, and the keys being fastened by glue. Mechanically operated inlet and exhaust valves are arranged in the cylinder head, and are provided with screws for balancing the opening effort due to centrifugal force.

The advantages of this engine from the viewpoint of specific weight (lb. per hp.), fuel consumption, power, and ease of construction, are illustrated in the following tables in comparison with the results obtained for two air-engines of about the same output, one of which is a radial engine (Climax), while the other is a stationary type (SE A 1).

TABLE I

Engine	By	H.p.m.	Weight (lb.)	Specific Consumption (lb. per hp. hr.)	Alt. (meters)
SE A 1	SE	100	100	1.10	40,000
Climax	C	100	100	1.10	40,000

TABLE II

Engine	Weight (lb.)	Consumption (lb. per hp. hr.)	Workable (lb. per hp. hr.)	Normal (lb. per hp. hr.)	Alt. (meters)
SE A 1	100	1.10	1.10	1.10	40,000
Climax	100	1.10	1.10	1.10	40,000

*Performance of rotary engine and power.

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9. Resist cracking.
10. Resist discoloring.
11. Resist staining.
12. Resist fading.
13. Resist weathering.
14. Resist abrasion.
15. Resist impact.
16. Resist fire.
17. Resist acids.
18. Resist alkalis.
19. Resist solvents.
20. Resist abrasion.
21. Resist impact.
22. Resist weathering.
23. Resist staining.
24. Resist fading.
25. Resist discoloring.
26. Resist cracking.
27. Resist discoloring.
28. Resist staining.
29. Resist abrasion.
30. Resist impact.
31. Resist weathering.
32. Resist staining.
33. Resist fading.
34. Resist discoloring.



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Name of Address in this form are printed in capital.
See Index in Advertisers on page 100.

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 American Aluminum Co.
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 Russell Aluminum & CO.
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图 2 为图 1 中 A 点的放大图, 图中 A 点位于

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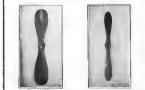
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